Center Innovation Fund: JPL CIF

Prototyping Tensegrity Lander Systems for Icy Terrain

Completed Technology Project (2016 - 2018)

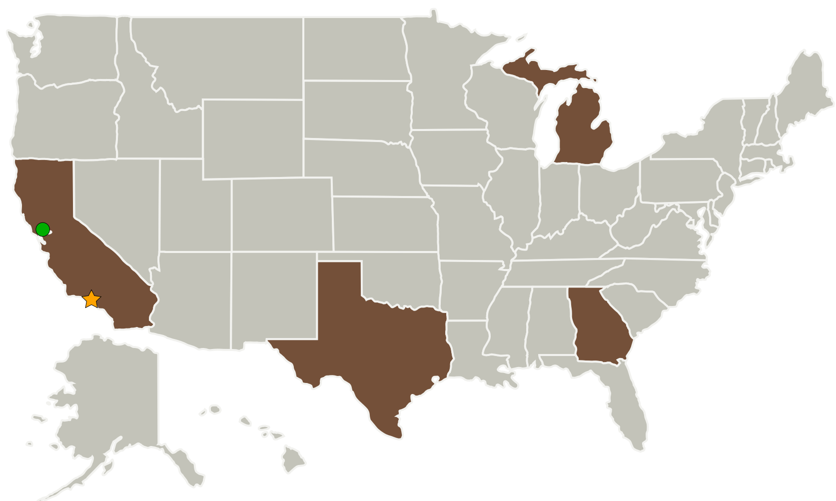
Project Introduction

Demonstrate that a tensegrity lander is a low-cost and revolutionary landing concept for exploring icy terrain where landing forces, payload protection and mobility are all integrated into a single structure built only from rods and flexible cables.

Anticipated Benefits

The novel lander system is capable of going places where rovers and current landers can't go, for example slopes, crevasses, loose soil/ice. It could be used as a secondary payload that offers redundant mission success, images from a new world (Philae as cautionary tale). Eventually primary landing using tensegrity opens new DV regime vs. airbag- and Skycrane-based approaches, potentially increased science per $.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
⭐Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California
🟢Ames Research Center(ARC)	Supporting Organization	NASA Center	Moffett Field, California
Georgia Institute of Technology-Main Campus(GA Tech)	Supporting Organization	Academia	Atlanta, Georgia
University of Michigan-Ann Arbor	Supporting Organization	Academia	Ann Arbor, Michigan

Primary U.S. Work Locations	
California	Georgia
Michigan	Texas

Project Transitions

October 2016: Project Start

September 2018: Closed out

Closeout Summary: This task explored a new application domain for the Tensegrity concept, a concept which has been around for decades. In particular, icy and granular material is an excellent application for Tensegrity systems, and a combination of the NASA Ames mobility systems with the JPL landing/payload system could be a powerful payload for novel mission architectures. Tensegrity systems for EDL function similarly to airbags, but without inflation. The struts of the inner structure are in compression against the tendons of the outer structure, and the system mechanically mimics an inflatable. One of the keys to this approach is operating in the buckling regime, allowing structural elements to store much more energy per kg of lander mass. Typical landers are structural trusses and must avoid buckling, while airbag landers require inflation and are vulnerable to punctures. In this task, the JPL team incorporated a computationally efficient model of tensegrity structures developed by Professor Julian Rimoli of Georgia Tech into lander studies to look at enabling new mission concepts.

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Innovation Fund: JPL CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

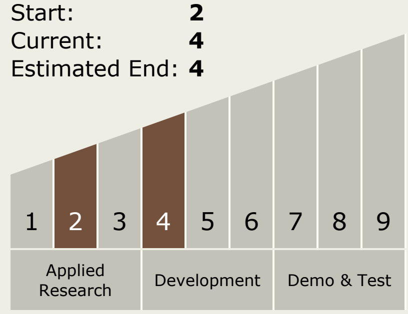
Fred Y Hadaegh

Principal Investigator:

Case Bradford

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Project Website:

https://www.nasa.gov/directorates/spacetech/innovation_fund/index.html#.VQ

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - └ TX12.2 Structures
    - └ TX12.2.1 Lightweight Concepts

Target Destinations

Earth, Mars, Others Inside the Solar System